



How Can You Most Effectively Work With DOE's National Labs?

*William Schertz
Laboratory Coordinating Council
DOE National Bioenergy Center
Strategic Partnerships Workshop
April 11 - 12, 2001
Lakewood, Colorado*



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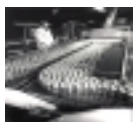
Agriculture



Mining



Metal Casting

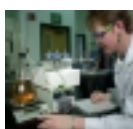


Aluminum

Industries of the Future



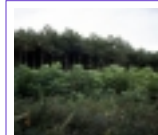
Steel



Chemicals



Petroleum



Forest Products



Glass

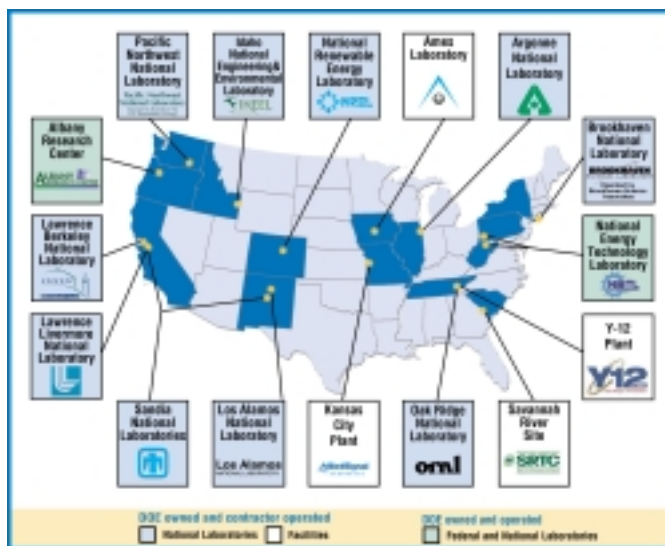
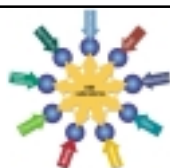


Laboratory Coordinating Council

*Fostering and Facilitating Collaborative R&D
in Support of the U.S. Department of Energy
Industries of the Future Initiatives*



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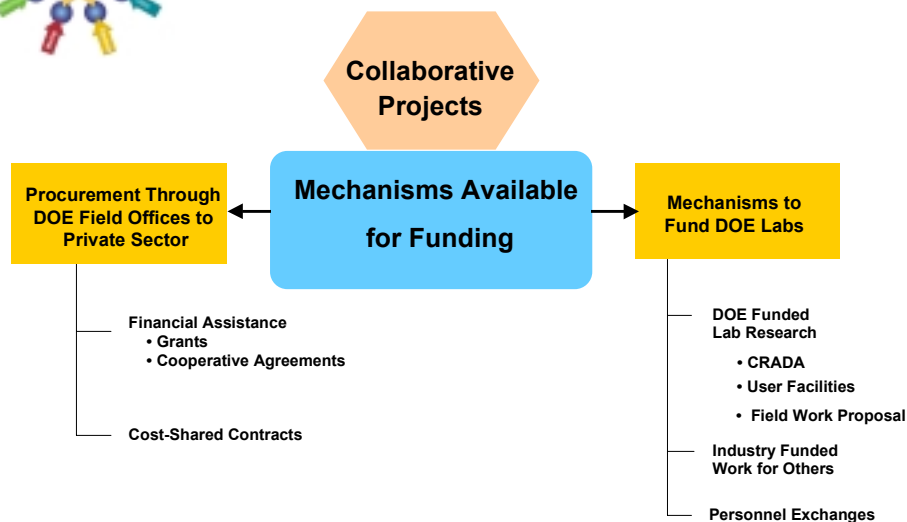


Laboratory Coordinating Council

- ◆ Support DOE's Industries of the Future initiatives
- ◆ Provide technical input to industry for developing technology roadmaps in cooperation with industry
- ◆ Simplify access to laboratories and facilities through a clear, flexible structure that is responsive to needs
- ◆ ***Stimulate and foster collaborations with industry and academia***



Partnering with Industries of the Future



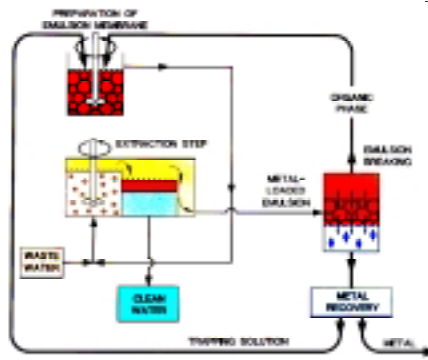


Agreements for Collaboration

Type of Agreement	Description	Protection of Information	Intellectual Property
CRADA - Cooperative Research and Development Agreement	Sets terms of collaboration with industry for R&D activities	May protect information generated under CRADA for up to 5 years; proprietary data protected	Each party retains title to own inventions. Option for royalty-bearing exclusive license to industry in field of use
WFO Non-Federal Work for Others	Permits industry and non-profit organizations to access unique research efforts at DOE laboratories	Data rights negotiable from fully proprietary to all parties can use data without restriction.	Title may go to sponsor under a DOE class waiver if DOE is not funding closely-related work at the laboratory
User Facilities Agreement	Provides access to certain dedicated DOE laboratory facilities	Proprietary and nonproprietary agreements possible	User inventions go to the user under a DOE class waiver



Waste waters from processing operations are a challenge to the industry. ARC has developed technology which can both mitigate the problem and recover valuable by-products



Liquid emulsion membrane technologies (LEM) have been demonstrated for copper recovery, uranium from AMD waters, and as part of an integrated treatment system for pulp and paper operations



Refractory Materials for Biomass Gasification Technologies



Refractory samples after exposure to simulated Biomass gasification environment



National Awards Related to Biobased Research at Argonne Include:

- President's Green Chemistry Challenge
- Discover Award for Technology Innovation
- DOE/OIT Technology of the Year (Finalist)
- Thiele Award (AIChE – Chemical Engineering)
- Federal Laboratory Consortium Award for Technology Transfer
- R&D 100 Award
- 3rd largest NIST/ATP award to date (\$31.3 million total)



Biobased Materials Strategic Initiative “Green” Solvent – Ethyl Lactate Process

Pilot Scale Electrodialysis System
used for industrial processing



Pervaporation-assisted
esterification
pilot unit

- “Green” Solvents Technology developed using advanced membranes technologies for bioprocessing
- Three companies were formed as a result
 - A specialty polymer company
 - Electrodialysis for industrial processes
 - Vertec Biosolvents is licensee with exclusive marketing arrangement with ADM
- Could replace up to 85% of toxic and chlorinated petrochemical solvents on a cost basis.



Biocatalytic Operating Systems

Vitamin C from Corn



- \$31.3 million NIST/ATP Program – 3rd largest awarded in history of ATP program
- Argonne is Joint Venture Partner with Eastman Chemical, Genencor, Electrosynthesis, and Microgenomics
- Argonne contributions included pathway engineering, enzyme recruitment from unculturables, enzyme stabilization, & issues related to biocatalytic systems.
- Plans announced to build fermentation-based plant with lowest-cost process to replace chemical process by 2003.
- Enzyme-based systems needed for ‘designer’ proteins but not yet feasible
- Limitations include cofactor costs and inability to engineer multi-enzyme sequential reactions.



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Core Competencies--Agriculture

- **Molecular and Structural Biology**
 - Transfer and Expression of Genetic Material
 - Protein/complex structure determination by X-ray crystallography
 - Enzyme or protein activity/performance enhancement through genetic engineering
- **Classical Microbiology**
 - Approaches to screening, classifying, enhancing microbial cultures
- **Genetics and Genomics**
 - Classical and molecular methods for analysis of crop traits
 - Techniques for crop trait improvement

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Core Competencies--Forest Products

- **Sustainable Forestry**
- **Human and Environmental Effects**
- **Energy & Environmental Tradeoffs**
- **Reduction of Impacts of Liquid Effluents**
- **Energy Conservation**
- **Combined Cycle Cogeneration**
- **Environmental Related Sensors**

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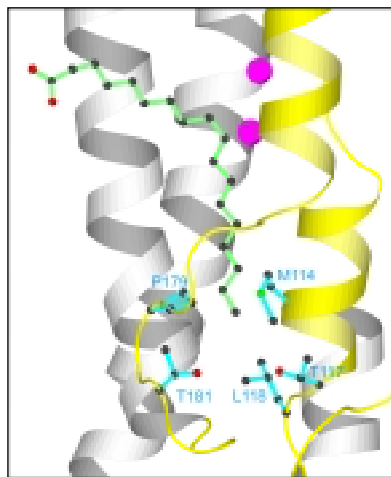


Enzyme Activity Enhancement & Modification

Soluble Acyl ACP-Desaturase

Structure-Function

- Wild Type Activity--Regio-specific insertion of first double bond in saturated fatty acid chains of specific lengths
- Structural studies identified amino acids important for chain length- and regio-specificity
- Site directed mutagenesis created enzymes with selectively altered regio- and chain length specificities for producing crop-based "designer" fatty acids to replace petrochemicals



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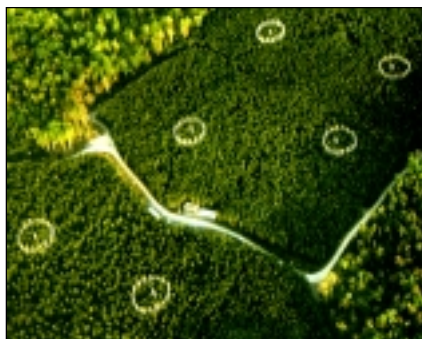
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Carbon Cycle/Forestry Management

Free Air Carbon Enrichment (FACE)

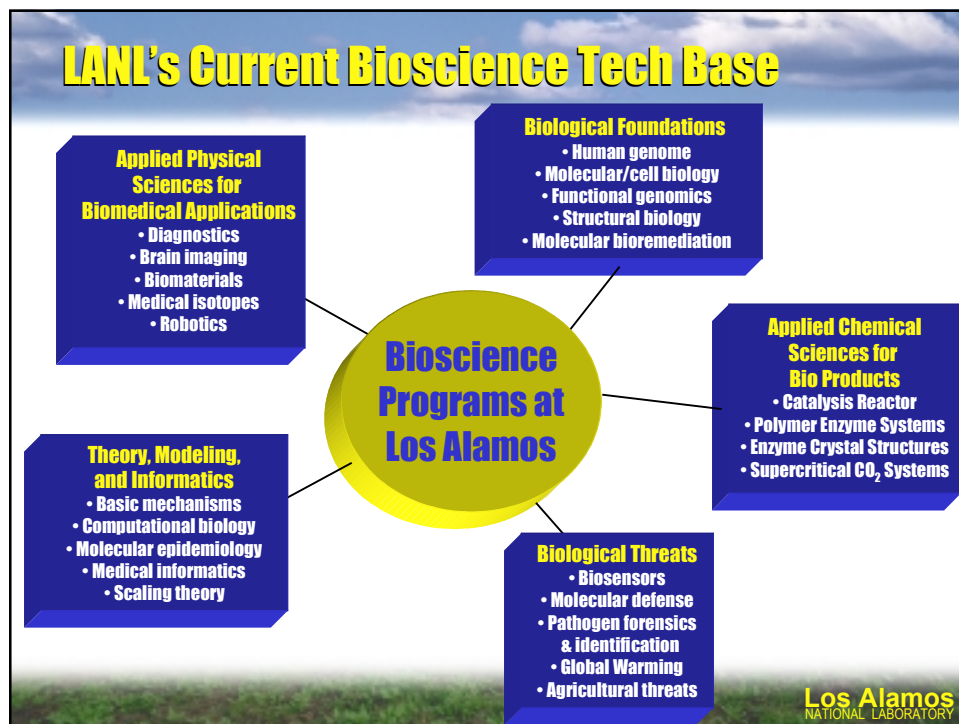
Forest-Atmospheric Carbon Transfer and Storage (FACTS-1)

- User Facility built by BNL in North Carolina
- Exposure CO₂ levels projected for year 2050 caused a 25% increase in growth rates



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IRIS: Infrared Imaging System for 100% Paper Moisture Measurement



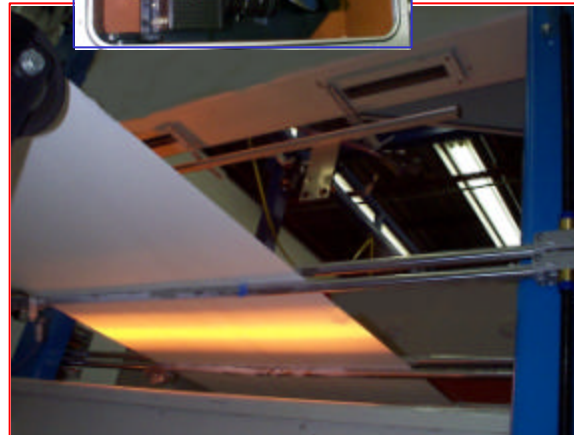
Conventional Paper Scanners

- slow mechanical systems
- sample < 2% of the sheet area
- require periodic maintenance
- limited process control

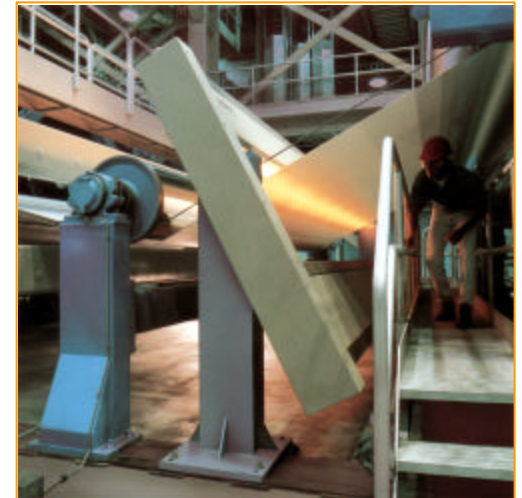
LLNL's Infrared Imaging System

- 100% coverage of the full sheet
- enables fast process control
- no moving parts

IRIS Prototype



Commercial IRIS Concept



Project Team

LLNL	R&D
ABB	Vendor
Westvaco	Paper mill
DOE-OIT	Sponsor

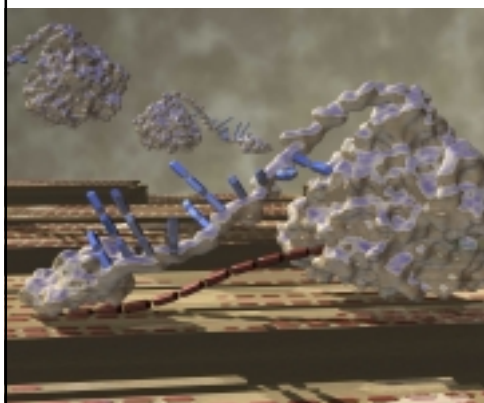
Examples of Recent NREL Bioenergy and Biobased Products Accomplishments

- Biofuels - Key cellulase enzyme understanding and development of new ethanol-producing strains
- Biopower - Technical assistance to small modular biopower systems
- Forest Products - Methodology for on-line process analysis and process control from seedling to the paper product
- Agriculture - Fast methodology for screening crop varieties for special properties -- field and laboratory



Process Demonstration Unit for Biofuels and Chemicals Production

Conversion of biomass into ethanol takes place in four 2300 gallon (9000L) fermentors - it's a lot of bugs & enzymes



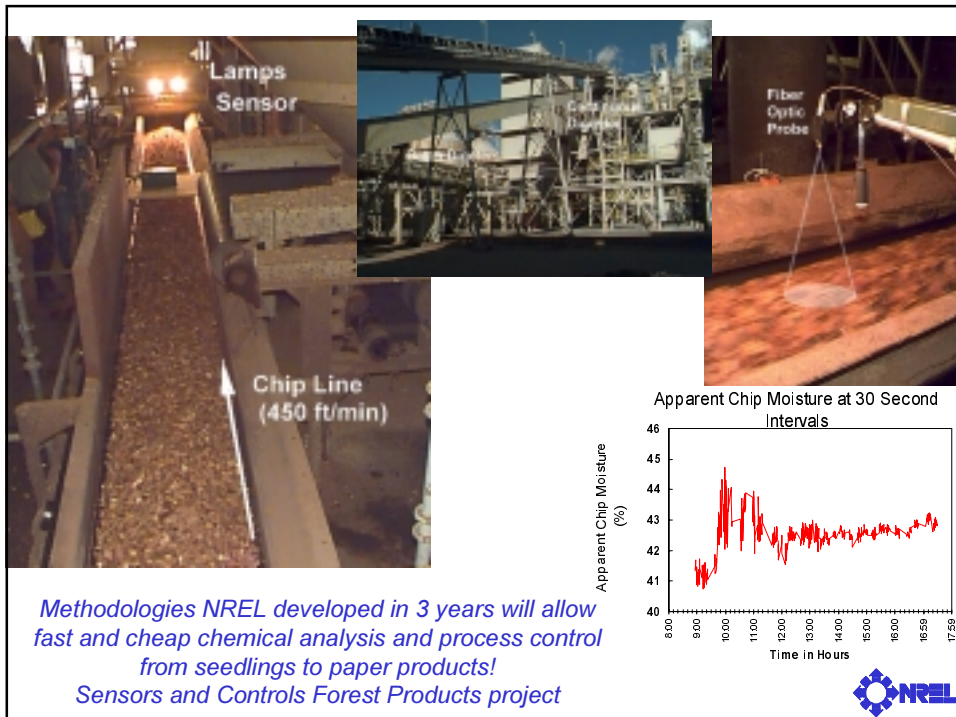
Enzymes walk down the biomass polymer degrading the long chain into bite-size chunks for microbes - New enzymes do it faster



**NREL supports Community Power Corporation, Aurora, CO
in assessing their 12 kWe unit for distributed power as part of
DOE's Small Modular Biopower Program**



- NREL provided environment, safety, and health review of the gasifier
- NREL staff provides system development technical support
- CPC's strategic partner, a major global company, is enthusiastic about the progress





NREL Staff and Equipment for Bioenergy and Biobased Products

Mobile equipment Permits on-site testing for processes and process control approaches

Picking a good one
You have to look at a lot of microbes to find the ones that will do the job



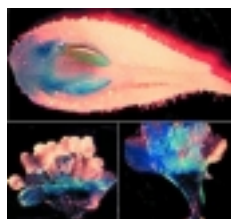
Preselecting trees

A simple probe might tell you the quality of the tree before it is felled



Biomass Resources Research & Development

Goal: Develop new biomass resources for bioenergy and bioproducts, through research in plant genetics, molecular biology, and agronomy, and facilitate their utilization by integrated analysis, systems engineering, and sustainability research



Major Activities:

- Managing biomass feedstock R&D for 2 DOE Programs ~ \$7 mil, FY01
- Partnering with many universities and federal programs (>30)
- Performing plant science, ecology, soil carbon R&D for DOE
- Focusing on Energy and Environmental Systems as major ORNL Initiative

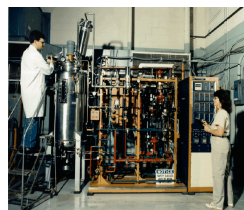
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Bioconversion Research & Development

Bioprocess Systems: Research on mechanisms of biological interactions on innovative processing concepts; Development of specialized bioprocessing systems, novel bioreactor concepts, and biocatalytic reagents (enzymatic or microbial).

Biomass to fuels and chemicals (Succinic acid)
Enzymatic production of hydrogen from biomass
Anaerobic digestion of animal wastes



Applied Biotechnology: Directed R&D on biological systems to solve real-world energy problems. Intact living microorganisms as well as cell-free, enzyme, and mimetic analogs are resources for bioconversion processes.

- Application of photosynthesis to production of hydrogen
- High temperature and modified cellulases for lignocellulosic hydrolysis
- Enzymatic redox reactions

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Enabling and Related Capabilities

Advanced Materials

e.g. Carbon fiber and composites, ceramics, properties measurement

Sensors and Instrumentation

e.g. Raman spectroscopy for soil carbon analysis

Organic and Biological Mass Spectrometry

e.g. mass spectrometry-based techniques for DNA sequencing and diagnostics

Seperations Research Center

e.g. Expertise in absorption, catalysis, filtration, electrophoresis, etc.

Advanced Computing e.g. Protein structure analysis

Bioinformatics and Functional genomics

e.g. Human genome information, application to microbial genomics

Micro CAT Scan Facilities

e.g. Detecting microstructures of biological materials

Microwave/RF Microstructure Modification Facilities

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PNNL Bio-Products Research

PNNL emphasizes conversion of readily available biomass resources to higher-value chemicals, fuel components, and power. Leading capabilities include:

- **Catalysis** – development of high-activity, high-selectivity catalysts for condensed phase hydrogenation and oxidation of sugars, organic acids, and vegetable oils
- **Fermentation** – discovery and development of novel eukaryotic organisms for use in fermentation systems
- **Pre-Treatment, Separations and Purification** – developing supporting processes to reduce overall biomass conversion costs and to improve final product purity and concentration

Pacific Northwest
National Laboratory

Sandia National Laboratories



- **Project Engineering:** Systems Engineering (integration, testing, planning, analysis, evaluation, manufacturing, materials, sensors, controls, MEMS)
- **Combustion Research:** Combustion Science (chemistry, kinetics, analysis, laboratory testing, sensor development, fuels characterization, ash analysis)
- **Watershed Management:** System Evaluation (water quality/quantity, forest management, fire impacts, economics, real-time monitoring)



Sandia National Laboratories



Guidelines for
Ash Deposition
Corrosion
NO_x and SO_x Formation
Char Burnout



IR Image of a burning biomass particle

